



April 2018, IPT Course
Introduction to Spring 5

Spring Persistence. JDBC. ORM. Transactions Hibernate

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Agenda for This Session

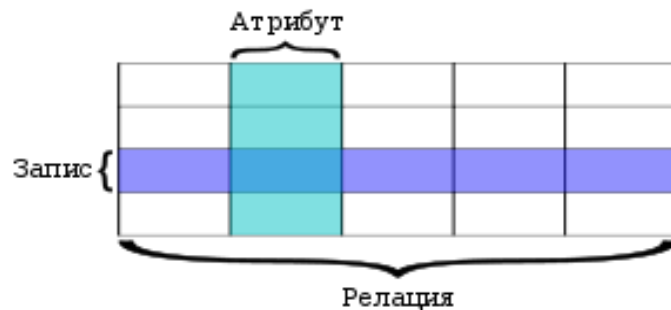
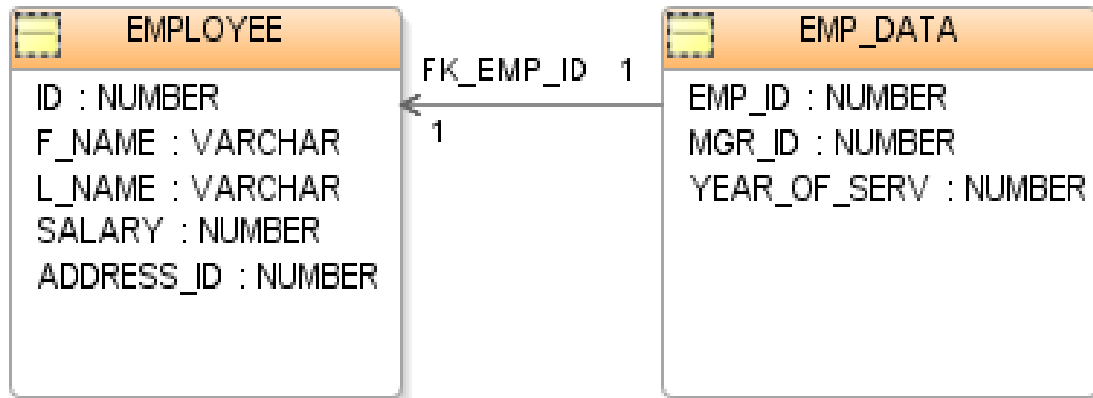
- ❖ DAO pattern.
- ❖ Spring JDBC Infrastructure
- ❖ Database Connections and DataSources
- ❖ Embedded database support
- ❖ Exception handling. JdbcTemplate class.
- ❖ Retrieving nested entities with ResultSetExtractor.
- ❖ Spring classes modelling main JDBC operations.
- ❖ Inserting data and retrieving the generated key.
- ❖ Spring Data project - JDBC extensions.
- ❖ Spring Boot starter JDBC.

Where to Find the Demo Code?

Introduction to Spring 5 demos and examples are available @ GitHub:

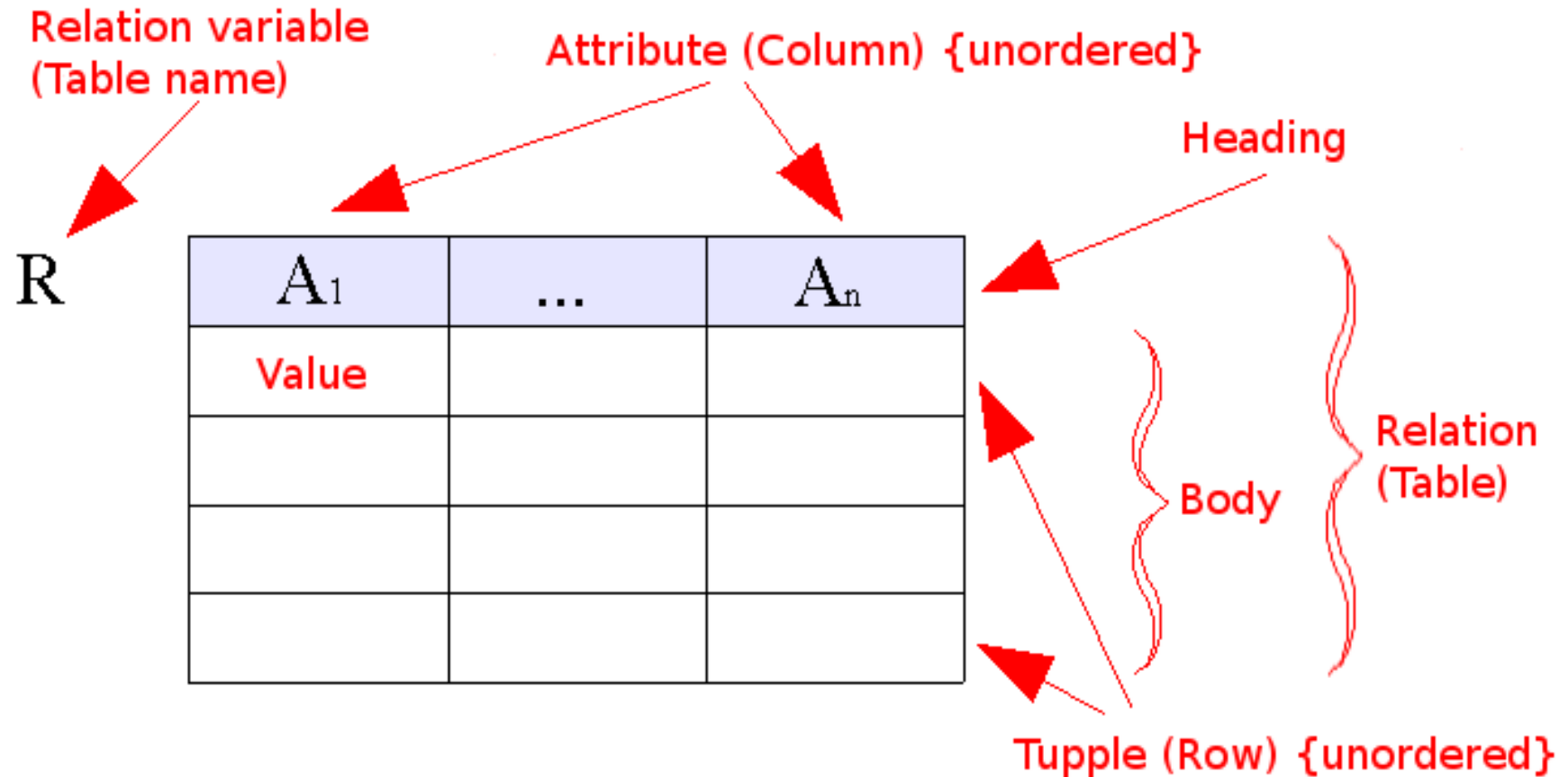
<https://github.com/iproduct/course-spring5>

Relational Model



- релация, релационна схема (relation) \leftrightarrow таблица (table),
- запис, кортеж (tuple) \leftrightarrow ред (row)
- атрибут, поле (attribute) \leftrightarrow стълб, колона (column)

Relational Model



Views. Domains. Constraints

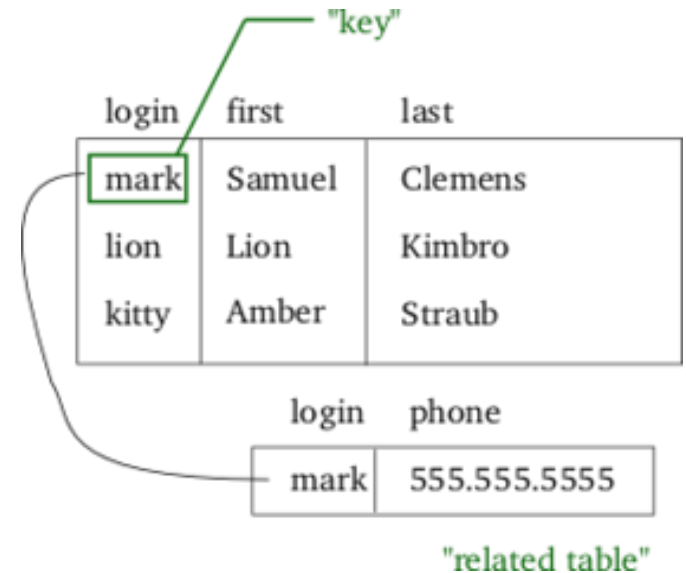
- ❖ **Def:** Relations which store primary data are called **base relations or tables**. Other relations, which are derived from primary relations are **queries** and **views**.
- ❖ **Def: Domain** in database is a set of allowed values for a given attribute in a relation – an existing constraint about valid the type of values for given attribute.
- ❖ **Def: Constraints** allow more flexible specification of values that are valid for given attribute – e.g. from 1 to 10.

Keys

❖ **Key** consists of one or more attributes, such as:

- 1) relation has no two records with the same values for these attributes
- 2) there is no proper subset of these attributes with the same property

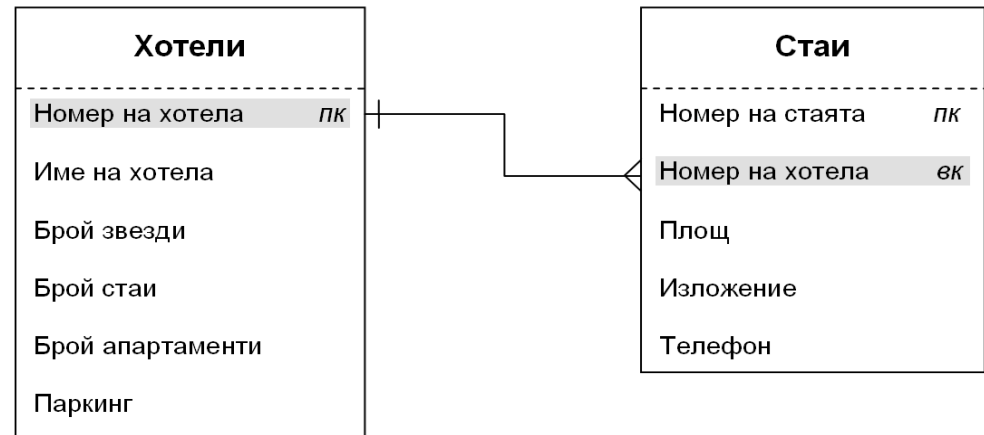
❖ **Primary Key** is an attribute (less frequently a group of attributes), which uniquely identifies each record (tuple) in the relation



❖ **Foreign key** is necessary when **there** exists a relation between two tables

Table Relations. Cardinality

❖ Relationship is a dependency existing between two tables, when the records from first table can be connected somehow with records from second one.

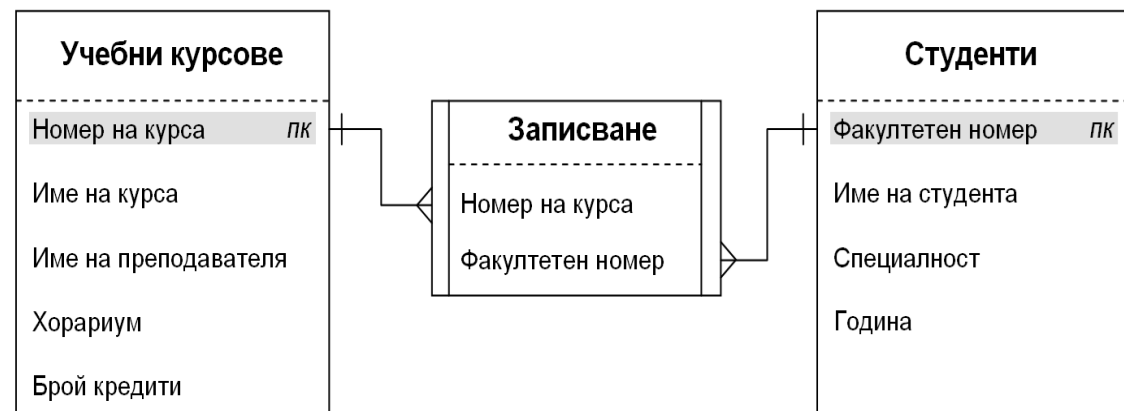


❖ Cardinality:

❖ One to one (1:1),

❖ One to many (1:N),

❖ Many to many (M:N)



Spring Data Access Objects (DAO)

- ❖ **Data Access Object (DAO)** – simplifies work with different data access technologies like **JDBC**, **Hibernate** or **JPA** in a consistent way.

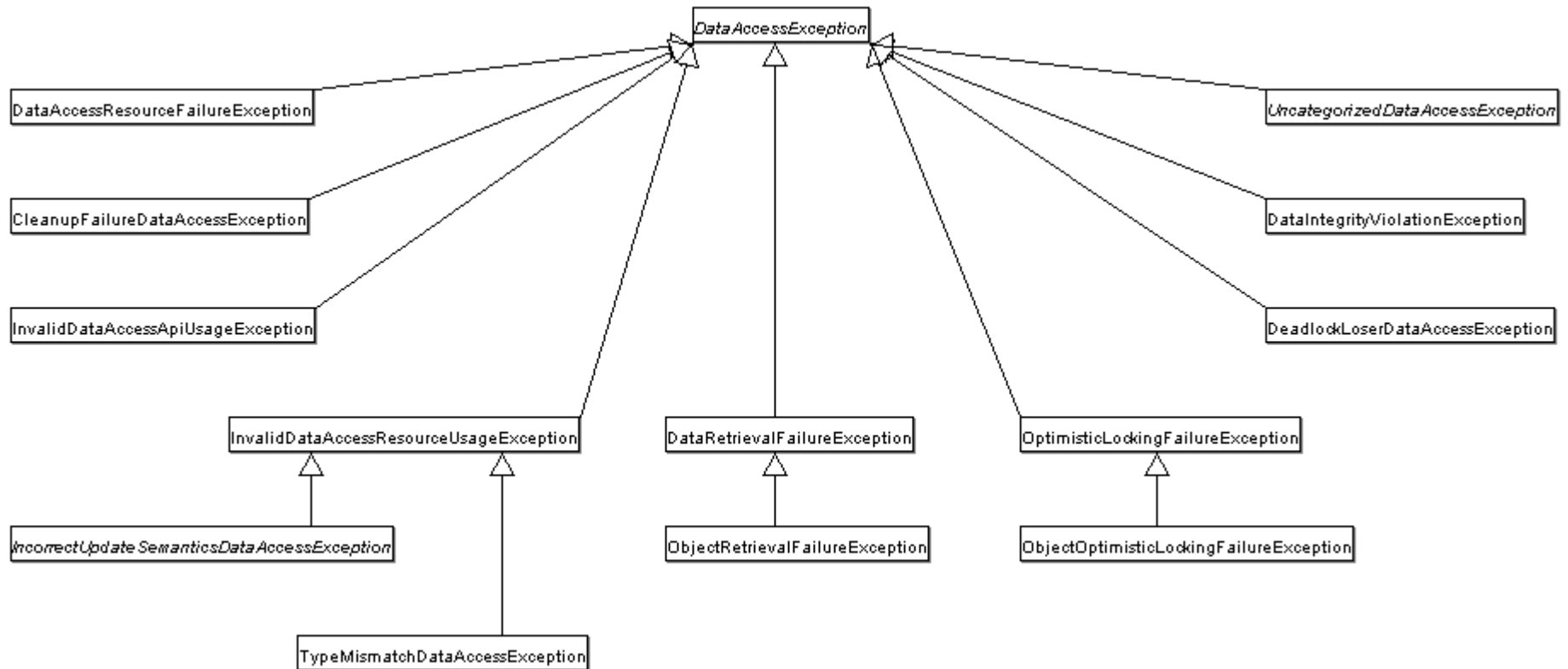
- ❖ Consistent exception hierarchy - **RuntimeExceptions**

- ❖ Annotations used for configuring **DAO** or **Repository** classes – with automatic exception translation:

```
import org.springframework.stereotype.Repository;

@Repository
public class SomeMovieFinder implements MovieFinder {
    // ...
}
```

DAO Exception Hierarchy



DAO Repository - JDBC

```
import javax.sql.DataSource;

@Repository
public class JdbcMovieFinder implements MovieFinder {

    private JdbcTemplate jdbcTemplate;

    @Autowired
    public void init(DataSource dataSource) {
        this.jdbcTemplate = new JdbcTemplate(dataSource);
    }

    // ...

}
```

DAO Repository - Hibernate

```
import org.hibernate.SessionFactory;
import

org.springframework.beans.factory.annotation.Autowired;
import org.springframework.stereotype.Repository;

@Repository
public class HibernateMovieFinder implements MovieFinder {

    private SessionFactory sessionFactory;

    @Autowired
    public void setSessionFactory(SessionFactory
sessionFactory) {
        this.sessionFactory = sessionFactory;
    }

    // ...
}
```

DAO Repository - JPA

```
import org.springframework.stereotype.Repository;

import javax.persistence.EntityManager;
import javax.persistence.PersistenceContext;

@Repository
public class JpaMovieFinder implements MovieFinder {

    @PersistenceContext
    private EntityManager entityManager;

    // ...

}
```


Spring JDBC

Action	Spring	You
Define connection parameters.		X
Open the connection.	X	
Specify the SQL statement.		X
Declare parameters and provide parameter values		X
Prepare and execute the statement.	X	
Set up the loop to iterate through the results (if any).	X	
Do the work for each iteration.		X
Process any exception.	X	
Handle transactions.	X	
Close the connection, statement and resultset.	X	

JDBC DB Access Alternatives

- ❖ **JdbcTemplate** - the “classic” Spring JDBC approach and the most popular - “lowest level”, all others use a JdbcTemplate
- ❖ **NamedParameterJdbcTemplate** – wraps a JdbcTemplate to provide named parameters instead of the “?” placeholders
- ❖ **SimpleJdbcInsert** and **SimpleJdbcCall** uses DB metadata, you only need to provide the name of the table or procedure and provide a map of parameters matching column names.
- ❖ **RDBMS Objects** – include **MappingSqlQuery**, **SqlUpdate** and **StoredProcedure**, you create reusable and thread-safe objects during initialization, like JDO Query, wherein you define your query string, declare parameters, and compile the query. Then you can execute methods multiple times.

JDBC Repository Methods - I

@Override

```
public Collection<Article> findAll() {  
    List<Article> articles = this.jdbcTemplate  
        .query("select * from articles", new  
ArticleMapper());  
    log.info("Articles loaded: {}", articles.size());  
    return articles;  
}
```

@Override

```
public Article find(long id) {  
    Article article = this.jdbcTemplate.queryForObject(  
        "select * from articles where id = ?",  
        new Object[]{id}, new ArticleMapper());  
    log.info("Article found: {}", article);  
    return article;  
}
```

JDBC Repository Methods - II

@Override

```
public Article create(Article article) {
    KeyHolder keyHolder = new GeneratedKeyHolder();
    jdbcTemplate.update(new PreparedStatementCreator() {
        public PreparedStatement createPreparedStatement
            (Connection connection) throws SQLException {
            PreparedStatement ps = connection
                .prepareStatement(INSERT_SQL, new String[] {"id"});
            ps.setString(1, article.getTitle());
            ps.setString(2, article.getContent());
            ps.setTimestamp(3, new Timestamp(
                article.getCreatedDate().getTime()));
            ps.setString(4, article.getPictureUrl());
            return ps;
        }
    }, keyHolder);
    article.setId(keyHolder.getKey().longValue());
    log.info("Article created: {}", article);
    return article;
}
```

JDBC Repository Methods - III

@Override

```
public Article update(Article article) {
    int count = this.jdbcTemplate.update(
        "update articles set (title, content, created_date, picture_url)
        VALUES (?, ?, ?, ?) where id = ?",
        article.getTitle(), article.getContent(),
        article.getCreatedDate(),
        article.getPictureUrl(), article.getId());
    log.info("Article updated: {}", article);
    return article;
}
```

@Override

```
public boolean remove(long articleId) {
    int count = this.jdbcTemplate.update(
        "delete from articles where id = ?",
        Long.valueOf(articleId));
    return count > 0;
}
```



Source: <https://docs.spring.io/spring-framework/docs/>

JDBC DataSource - I

@Configuration

@ComponentScan({"org.iproduct.spring.webmvc.service",
"org.iproduct.spring.webmvc.dao"})

@PropertySource("classpath:jdbc.properties")

public class SpringRootConfig {

@Value("\${jdbc.driverClassName:org.postgresql.Driver}")

private String driverClassname;

@Value("\${jdbc.url:jdbc:postgresql://localhost/articles}")

private String url;

@Value("\${jdbc.username:postgres}")

private String username;

@Value("\${jdbc.password:postgres}")

private String password;

(- continues on next slide -)

JDBC DataSource - II

@Bean

```
DataSource getDataSource() {  
    DriverManagerDataSource dataSource =  
        new DriverManagerDataSource();  
    //PostgreSQL database we are using  
    dataSource.setDriverClassName(driverClassname);  
    dataSource.setUrl(url); //change url  
    dataSource.setUsername(username); //change username  
    dataSource.setPassword(password); //change pwd  
  
    //H2 database  
    /*  
    dataSource.setDriverClassName("org.h2.Driver");  
    dataSource.setUrl("jdbc:h2:tcp://localhost/~/test");  
    dataSource.setUsername("sa");  
    dataSource.setPassword(""); */  
    return dataSource;  
}
```

Hibernate DAO

```
import org.hibernate.SessionFactory;
import

org.springframework.beans.factory.annotation.Autowired;
import org.springframework.stereotype.Repository;

@Repository
public class HibernateMovieFinder implements MovieFinder {

    private SessionFactory sessionFactory;

    @Autowired
    public void setSessionFactory(
        SessionFactory sessionFactory) {
        this.sessionFactory = sessionFactory;
    }
    // ...
}
```

Web_INITIALIZER – XML Root Config

```
public class ArticlesWebInitializer extends
    AbstractAnnotationConfigDispatcherServletInitializer {
    @Override
    protected WebApplicationContext
        createRootApplicationContext() {
        return new XmlWebApplicationContext();
    }

    @Override
    protected Class<?>[] getRootConfigClasses() {
        return new Class[0];
    }

    @Override
    protected Class<?>[] getServletConfigClasses() {
        return new Class<?>[] { SpringWebConfig.class };
    }
}
```

WEB-INF/applicationContext.xml - I

```
<?xml version="1.0" encoding="UTF-8"?>
<beans xmlns="http://www.springframework.org/schema/beans"
       xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
       xmlns:context="http://www.springframework.org/schema/context"
       xmlns:aop="http://www.springframework.org/schema/aop"
       xmlns:tx="http://www.springframework.org/schema/tx"
       xsi:schemaLocation="http://www.springframework.org/schema/beans
                           http://www.springframework.org/schema/beans/spring-beans.xsd
                           http://www.springframework.org/schema/context
                           http://www.springframework.org/schema/context/spring-context.xsd
                           http://www.springframework.org/schema/tx
                           http://www.springframework.org/schema/tx/spring-tx.xsd
                           http://www.springframework.org/schema/aop
                           http://www.springframework.org/schema/aop/spring-aop.xsd">

    <context:property-placeholder location="classpath:jdbc.properties" />

    <context:component-scan base-package="org.iproduct.spring.webmvc.dao,
        org.iproduct.spring.webmvc.service"/>

    <context:annotation-config />
```


WEB-INF/applicationContext.xml -II

```
<bean id="dataSource" class="org.apache.commons.dbcp2.BasicDataSource"
    destroy-method="close">
    <property name="driverClassName" value="${jdbc.driverClassName}" />
    <property name="url" value="${jdbc.url}" />
    <property name="username" value="${jdbc.username}" />
    <property name="password" value="${jdbc.password}" />
</bean>

<bean id="sessionFactory"
    class="org.springframework.orm.hibernate5.LocalSessionFactoryBean">
    <property name="dataSource" ref="dataSource"/>
    <property name="mappingResources">
        <list><value>article.hbm.xml</value></list>
    </property>
    <property name="hibernateProperties">
        <value>
            hibernate.dialect=org.hibernate.dialect.HSQLDialect
            hibernate.hbm2ddl.auto=update
        </value>
    </property>
</bean>
```

WEB-INF/applicationContext.xml III

```
<bean id="transactionManager"  
      class="org.springframework.orm.hibernate5.HibernateTransactionManager">  
    <property name="sessionFactory" ref="sessionFactory"/>  
</bean>  
  
<tx:annotation-driven/>  
  
</beans>
```

Hibernate Mapping: article.hbm.xml

```
<hibernate-mapping>
  <class name="org.iproduct.spring.webmvc.model.Article" table="ARTICLES">

    <meta attribute="class-description">
      This class contains the articles details.
    </meta>

    <id name="id" type="long" column="id">
      <generator class="identity"/>
    </id>

    <property name="title" column="title" type="string"/>
    <property name="content" column="content" type="string"/>
    <property name="createdDate" column="created_date" type="timestamp"/>
    <property name="pictureUrl" column="picture_url" type="string"/>

  </class>
</hibernate-mapping>
```

ArticlesDaoHibernate Class - I

```
@Repository
@Transactional
public class ArticleDaoHibernate implements ArticleDao {

    private SessionFactory sessionFactory;

    @Autowired
    public void setSessionFactory(SessionFactory sessionFactory) {
        this.sessionFactory = sessionFactory;
    }

    @Override
    public Collection<Article> findAll() {
        return this.sessionFactory.getCurrentSession()
            .createQuery("select article from Article article", Article.class)
            .list();
    }

    @Override
    public Article find(long id) {
        return this.sessionFactory.getCurrentSession()
            .byId(Article.class).load(id);
    }
}
```

ArticlesDaoHibernate Class - II

```
@Override
public Article create(Article article) {
    this.sessionFactory.getCurrentSession()
        .persist(article);
    return article;
}

@Override
public Article update(Article article) {
    Article toBeDeleted = find(article.getId());
    if (toBeDeleted == null) {
        throw new EntityNotExistException("Article "+article.getId()+" not exist.");
    }
    return (Article) this.sessionFactory.getCurrentSession()
        .merge(article);
}

@Override
public Article remove(long articleId) {
    Article toBeDeleted = find(articleId);
    if (toBeDeleted == null) {
        throw new EntityNotExistException("Article "+article.getId()+" not exist.");
    }
    this.sessionFactory.getCurrentSession()
        .delete(toBeDeleted);
    return toBeDeleted;
}}
```


Transactions and Concurrency

❖ **Transaction** = Commits as **Business Event**

❖ **ACID rules:**

❖ **Atomicity** – the whole transaction is completed (commit) or no part is completed at all (rollback).

❖ **Consistency** – transaction should preserve existing integrity constraints

❖ **Isolation** – two uncompleted transactions can not interact

❖ **Durability** – successfully completed transactions can not be rolled back

Advantages of Spring Transactions

- ❖ **Consistent** programming model across different transaction APIs such as Java Transaction API (JTA), JDBC, Hibernate, and Java Persistence API (JPA).
- ❖ Support for **declarative transaction** management.
- ❖ Simpler API for **programmatic transaction management** than complex transaction APIs such as JTA.
- ❖ Excellent **integration** with Spring's data access abstractions.

Spring Transaction Management

- ❖ **Global transactions** – enable you to work with multiple transactional resources, typically relational databases and message queues (JTA UserTransaction, JNDI lookup).
- ❖ **Local transactions** – resource-specific, such as a transaction associated with a JDBC connection, but cannot work across multiple transactional resources.
- ❖ **Spring Framework's transactions** – consistent programming model in any environment, write code once, and it can use different transaction management strategies in different environments – both **declarative and programmatic transaction management** (Spring Framework transaction abstraction).

Spring Transaction Abstraction

```
public interface PlatformTransactionManager {  
  
    TransactionStatus getTransaction(TransactionDefinition definition)  
        throws TransactionException;  
  
    void commit(TransactionStatus status) throws TransactionException;  
  
    void rollback(TransactionStatus status) throws TransactionException;  
}
```

❖ TransactionDefinition:

- **Propagation** – what to do when a transactional method is executed when a transaction context already exists)
- **Isolation** – degree to which this transaction is isolated from the work of other transactions (e.g. can this transaction see uncommitted writes from other transactions?)
- **Timeout** – how long run before timing out and being rolled back
- **Read-only status**: used when you read but not modify data

Transaction Isolation Levels

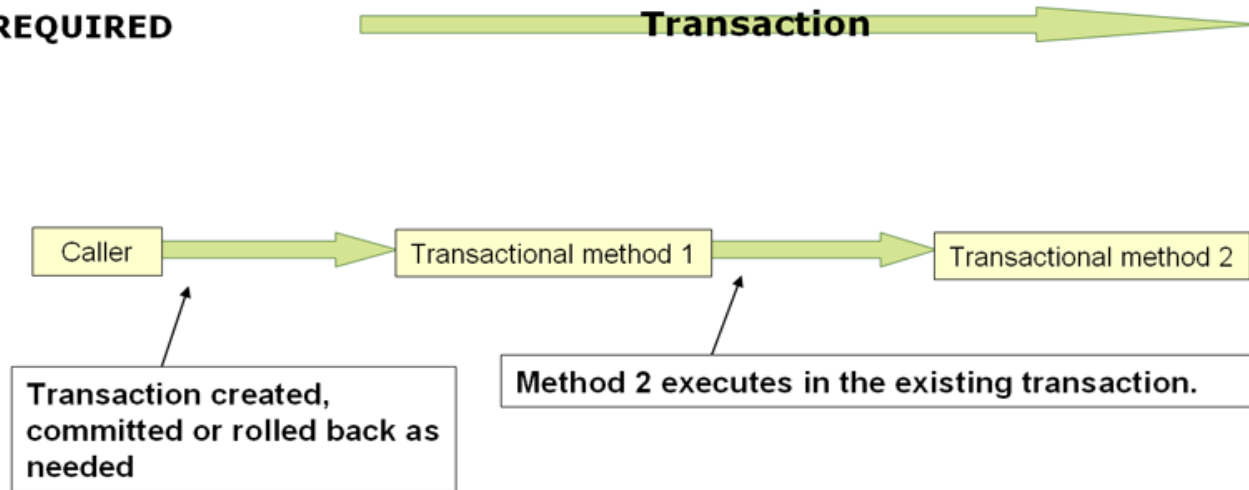
- ❖ **DEFAULT** - use the default isolation level of the underlying datastore
- ❖ **READ_UNCOMMITTED** – dirty reads, non-repeatable reads and phantom reads can occur
- ❖ **READ_COMMITTED** – prevents dirty reads; non-repeatable reads and phantom reads can occur
- ❖ **REPEATABLE_READ** – prevents dirty reads and non-repeatable reads; phantom reads can occur
- ❖ **SERIALIZABLE** – prevents dirty reads, non-repeatable reads and phantom reads

Transactions Propagation

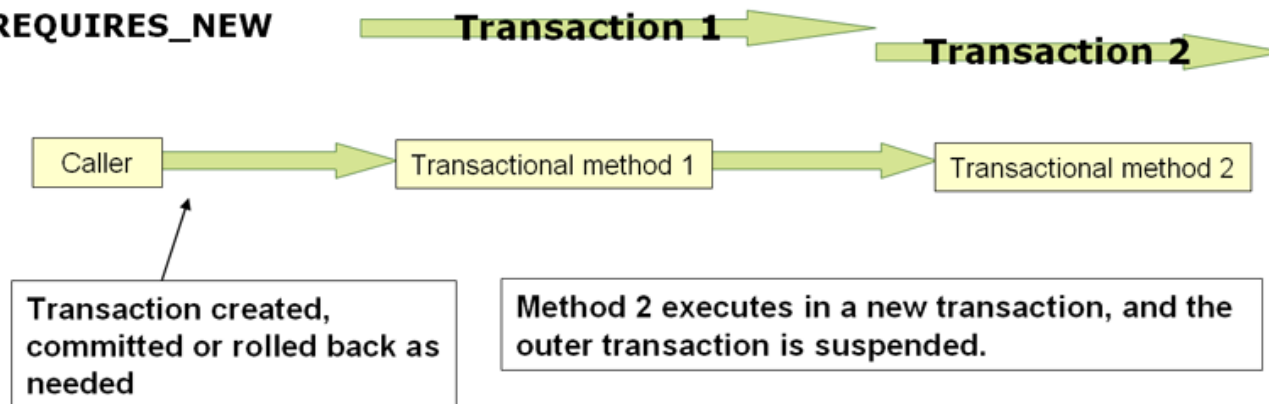
- ❖ **SUPPORTS** – supports transaction if existing, executes non-transactionally if not
- ❖ **REQUIRED** – supports transaction if existing, creates new if not
- ❖ **REQUIRES_NEW** – always create a new transaction, and suspend the current transaction if one exists
- ❖ **MANDATORY** – supports the current transaction, throws an exception if none exists
- ❖ **NEVER** – execute non-transactionally, throw an exception if a transaction exists
- ❖ **NOT_SUPPORTED** - execute non-transactionally, suspend the current transaction if one exists
- ❖ **NESTED** – executes within a nested transaction if current transaction exists, else does like **PROPAGATION_REQUIRED**

Transactions Propagation

REQUIRED



REQUIRES_NEW



TransactionStatus

```
public interface TransactionStatus extends SavepointManager {  
  
    boolean isNewTransaction();  
  
    boolean hasSavepoint();  
  
    void setRollbackOnly();  
  
    boolean isRollbackOnly();  
  
    void flush();  
  
    boolean isCompleted();  
  
}
```

Transactions and Concurrency

- ❖ **DataSourceTransactionManager** – JDBC local transactions, allows thread bound connections, obtained

```
<bean id="txManager"
class="org.springframework.jdbc.datasource.DataSourceTransactionManager"
>
    <property name="dataSource" ref="dataSource"/>
</bean>
```

- ❖ **JtaTransactionManager** – using global JTA transactions

```
<jee:jndi-lookup id="dataSource" jndi-name="jdbc/articles"/>
<bean id="txManager"
    class="org.springframework.transaction.jta.JtaTransactionManager"/>
```

- ❖ **@Transactional** – declarative transactions

- ❖ **TransactionTemplate** or directly using **PlatformTransactionManager** – programmatic transactions

Declarative Transaction Demarcation

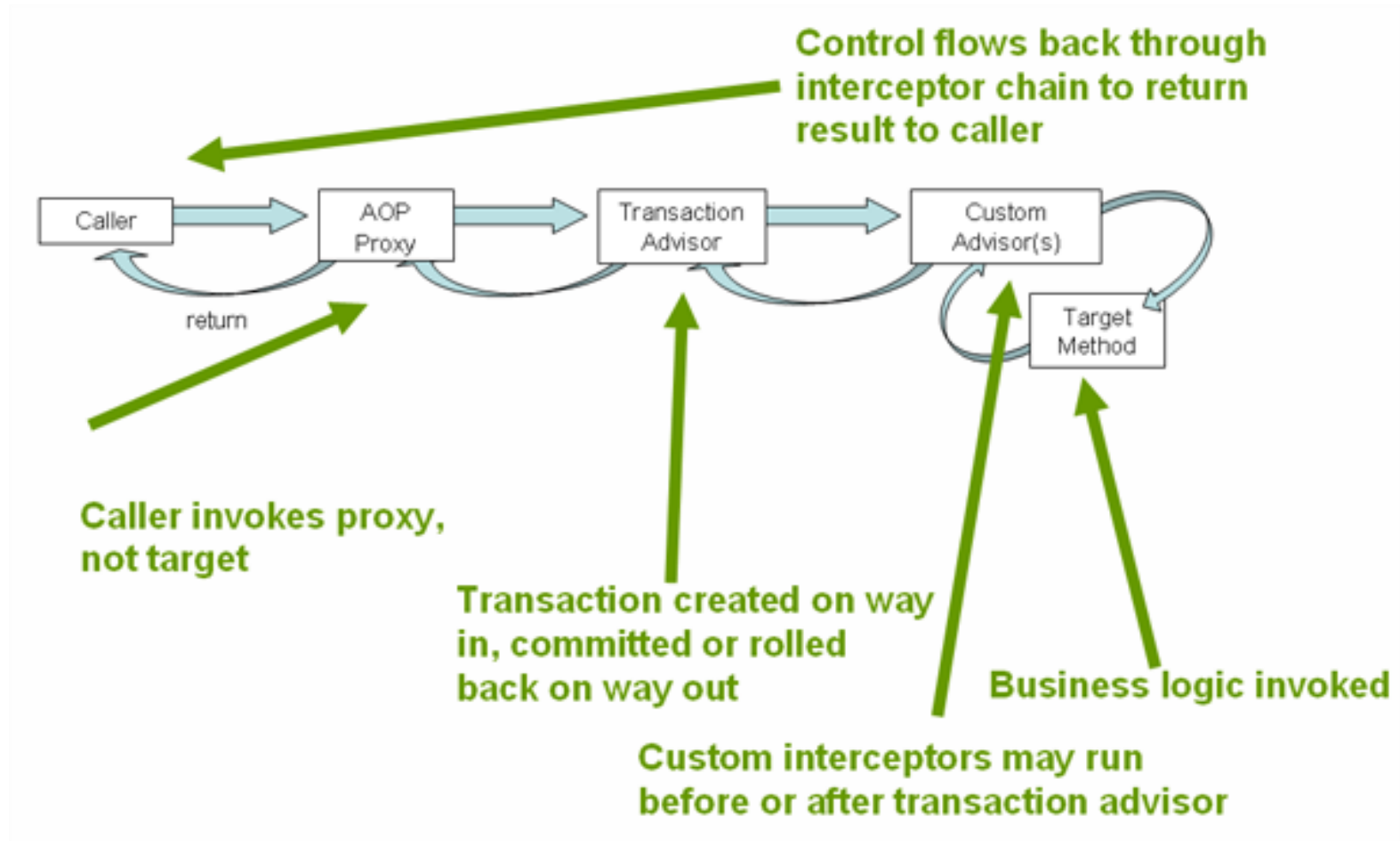
❖ Enabling declarative transactions:

- **@EnableTransactionManagement**
- **<tx:annotation-driven/>**

❖ **@Transactional** attributes: **value** (optional qualifier specifying the transaction manager to be used), **propagation**, **isolation**, **readOnly**, **timeout** (in seconds), **rollbackFor** (optional array of exception classes that must cause rollback), **rollbackForClassName**, **noRollbackFor** (optional array of exception classes that must not cause rollback), **noRollbackForClassName**

```
@Transactional(propagation = Propagation.REQUIRED)
public List<Article> createArticlesBatch(List<Article>
articles) {
    List<Article> created = articles.stream()
        .map(article -> addArticle(article))
        .collect(Collectors.toList());
    return created;
}
```

Transactions via AOP Proxies



Customizing Transactions using AOP

```
<aop:config>
  <aop:pointcut id="entryPointMethod"
    expression="execution(* x.y..*Service.*(..))"/>

  <aop:advisor advice-ref="txAdvice" pointcut-ref="entryPointMethod"
    order="2"/>

  <aop:aspect id="profilingAspect" ref="profiler">
    <aop:pointcut id="methodWithReturn"
      expression="execution(!void x.y..*Service.*(..))"/>
    <aop:around method="profile" pointcut-ref="methodWithReturn"/>
  </aop:aspect>
</aop:config>

<tx:advice id="txAdvice" transaction-manager="txManager">
  <tx:attributes>
    <tx:method name="get*" read-only="true"/>
    <tx:method name="*" />
  </tx:attributes>
</tx:advice>
```


Programmatic Transactions - I

```
public List<Article> createArticlesBatch(List<Article> articles)
{
    return transactionTemplate.execute(
        new TransactionCallback<List<Article>>() {
            public List<Article> doInTransaction(
                TransactionStatus status)
            {
                List<Article> created = articles.stream()
                    .map(article -> {
                        try {
                            return addArticle(article);
                        } catch (ConstraintViolationException ex) {
                            log.error("Error:{}", ex.getMessage());
                            status.setRollbackOnly();
                            return null;
                        }
                    })
                    .collect(Collectors.toList());
                return created;
            }
        });
}
```

Programmatic Transactions - II

```
public List<Article> createArticlesBatch(List<Article> articles) {
    DefaultTransactionDefinition def = new DefaultTransactionDefinition();
    def.setPropagationBehavior(TransactionDefinition.PROPGATION_REQUIRED);
    def.setTimeout(5);

    TransactionStatus status = transactionManager.getTransaction(def);
    List<Article> created = articles.stream()
        .map(article -> {
            try {
                Article resultArticle = addArticle(article);
                applicationEventPublisher.publishEvent(
                    new ArticleCreationEvent(resultArticle));
                return resultArticle;
            } catch (ConstraintViolationException ex) {
                log.error("Error: {}", ex.getMessage());
                transactionManager.rollback(status); // ROLLBACK
                throw ex;
            }
        })
        .collect(Collectors.toList());
    transactionManager.commit(status); // COMMIT
    return created;
}
```

@TransactionalEventListener

```
@TransactionalEventListener
```

```
public void
```

```
handleArticleCreatedTransactionCommit(ArticleCreationEvent  
creationEvent) {
```

```
    log.info(">>> Transaction COMMIT for article: {}",  
            creationEvent.getArticle());
```

```
}
```

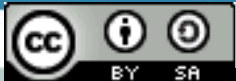
```
@TransactionalEventListener(phase = TransactionPhase.AFTER_ROLLBACK)
```

```
public void
```

```
handleArticleCreatedTransactionRollback(ArticleCreationEvent  
creationEvent) {
```

```
    log.info(">>> Transaction ROLLBACK for article: {}",  
            creationEvent.getArticle());
```

```
}
```



Source: <https://docs.spring.io/spring-framework/docs/>

Java Persistence API (JPA)

❖ JPA four main parts:

- Java Persistence API
- JPA Query Language
- Java Persistence Criteria API
- Object to Relational Mapping (ORM) metadata

❖ JPA Entity Classes

- persistent fields
- persistent properties

❖ @Entity annotation

Object-Relational Mapping (ORM)

- ❖ Package: javax.persistence
- ❖ Simple keys - **@Id** annotation
- ❖ Composite keys
 - **Primary Key Class** – requirements and structure
 - Annotations – **@EmbeddedId**, **@IdClass**
- ❖ Relations between entity objects –
 - **uni- and bi-directional**,
 - **1:1, 1:many, many:1 many:many**

Advantages of Spring ORM

- ❖ Easier testing
- ❖ Common data access exceptions
- ❖ General resource management
- ❖ Integrated transaction management

ORM Cascade Updates

❖ Entities that have a dependency relationship can be managed declaratively by JPA using **CascadeType**:

- **ALL** – всички операции са каскадни
- **DETACH** – каскадно отстраняване
- **MERGE** – каскадно сливане
- **PERSIST** – каскадно персистиране
- **REFRESH** – каскадно обновяване
- **REMOVE** – каскадно премахване

**@OneToMany(cascade=REMOVE,
mappedBy="customer")**

```
public Set<Order> getOrders() { return orders; }
```

Entity Embeddables

- ❖ **@Embeddable** – аотира клас, който не е Entity, но може да бъде част от Entity
- ❖ **@Embedded** – embeds Embeddable class into Entity class
- ❖ Embedding can be hierarchical on multiple levels
- ❖ Annotations: **@AttributeOverride**, **@AttributeOverrides**, **@AssociationOverride**, **@AssociationOverrides**

Entity Inheritance

- ❖ Entity / Abstract entity
- ❖ Mapped superclass
- ❖ Non-entity superclass
- ❖ Entity -> DB tables mapping strategies
 - SingleTable per Class Hierarchy
 - TheTable per Concrete Class
 - The Joined Subclass Strategy

Persistent Units

❖ Persistent Unit description in **persistence.xml** file:

- description
- provider
- jta-data-source
- non-jta-data-source
- mapping-file
- jar-file
- class
- exclude-unlisted-classes
- properties

Persistent Unit Example 1

```
<persistence xmlns="http://java.sun.com/xml/ns/persistence"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  version="1.0"
  xsi:schemaLocation="http://java.sun.com/xml/ns/persistence
    http://java.sun.com/xml/ns/persistence/persistence_1_0.xsd">
  <persistence-unit name="CustomerDBPU" transaction-type="JTA">
    <jta-data-source>jdbc/sample</jta-data-source>
    <class>customerdb.Customer</class>
    <class>customerdb.DiscountCode</class>
    <properties/>
  </persistence-unit>
</persistence>
```

Persistent Unit Example 2 - I

```
<?xml version="1.0" encoding="UTF-8"?>
<persistence version="1.0"
  xmlns="http://java.sun.com/xml/ns/persistence"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="http://java.sun.com/xml/ns/persistence
    http://java.sun.com/xml/ns/persistence/persistence_1_0.xsd">
  <persistence-unit name="invoicingPU"
    transaction-type="RESOURCE_LOCAL">
    <provider>oracle.toplink.essentials.PersistenceProvider</provider>
    <class>myinvoice.dbentities.ProductDB</class>
    <class>myinvoice.dbentities.PositionDB</class>
    <class>myinvoice.dbentities.InvoiceDB</class>
```


Persistent Unit Example 2 - II

```
<class>myinvoice.dbentities.ContragentDB</class>
```

```
<properties>
```

```
  <property name="toplink.jdbc.user" value="root"/>
```

```
  <property name="toplink.jdbc.password" value="root"/>
```

```
  <property name="toplink.jdbc.url"
    value="jdbc:mysql://localhost:3306/invoicing"/>
```

```
  <property name="toplink.jdbc.driver"
    value="com.mysql.jdbc.Driver"/>
```

```
</properties>
```

```
</persistence-unit>
```

```
</persistence>
```

Collection Type Persistent Fields

❖ Field or properties should be of **Collection** or **Map** type (usually generic):

- `java.util.Collection`
- `java.util.Set`
- `java.util.List`
- `java.util.Map`

❖ **@ElementCollection**

❖ **@CollectionTable** – name of additional table

❖ **@Embeddable**, **@Column**

❖ **@AttributeOverride**, **@AttributeOverrides**

Main JPA Annotations

❖ @PersistenceUnit,

❖ @PersistenceContext

❖ @Entity

❖ @Id

❖ @OneToOne

❖ @OneToMany

❖ @ManyToMany

❖ @DiscriminatorColumn

❖ @Column

❖ @JoinTable

❖ @JoinColumn

❖ @Embeddable

❖ @Embedded

JPA Entity Annotations Example

```
@Entity
public class Article {
    @Id
    @GeneratedValue
    private Long id;

    @Length(min=3, max=80)
    private String title;

    @Length(min=3, max=2048)
    private String content;

    @NotNull
    @ManyToOne
    @JoinColumn(name="AUTHOR_ID", nullable=false)
    private User author;

    @Length(min=3, max=256)
    private String pictureUrl;

    @Temporal(TemporalType.TIMESTAMP)
    private Date created = new Date();

    @Temporal(TemporalType.TIMESTAMP)
    private Date updated = new Date();

    ...
}
```



```
@Entity
public class User implements UserDetails {
    @Id
    @GeneratedValue
    private long id;

    @NotNull
    @Length(min = 3, max = 30)
    private String username;
    ...

    @NotNull
    private String roles = "ROLE_USER";

    @OneToMany(mappedBy = "author",
        cascade = CascadeType.ALL,
        orphanRemoval=true)
    Collection<Article> articles =
        new ArrayList<>();

    @Temporal(TemporalType.TIMESTAMP)
    private Date created = new Date();

    @Temporal(TemporalType.TIMESTAMP)
    private Date updated = new Date();

    ...
}
```

JPA Entities: @ManyToMany

```
@Entity
public class Book {
    @Id @GeneratedValue
    private int id;

    @NotNull
    private String title;

    @ManyToOne
    @JoinColumn(name = "PUBLISHER_ID",
        referencedColumnName = "id")
    private Publisher publisher;

    @Column(name = "PUBLISHED_DATE") @PastOrPresent
    @DateTimeFormat(iso = DateTimeFormat.ISO.DATE)
    private LocalDate publishedDate;

    @Pattern(regexp = "\\d{10}|\\d{13}")
    private String isbn;

    @NotNull @Min(0)
    private double price;

    @ManyToMany(fetch = FetchType.EAGER)
    @JoinTable(name="BOOK_AUTHOR", joinColumns=
        @JoinColumn(name="BOOK_ID",referencedColumnName="ID"),
        inverseJoinColumns=
        @JoinColumn(name="AUTHOR_ID",referencedColumnName="ID")
    )
    private List<Author> authors = new ArrayList<>();
... }
```

```
@Entity
public class Author {
    @Id @GeneratedValue
    private int id;

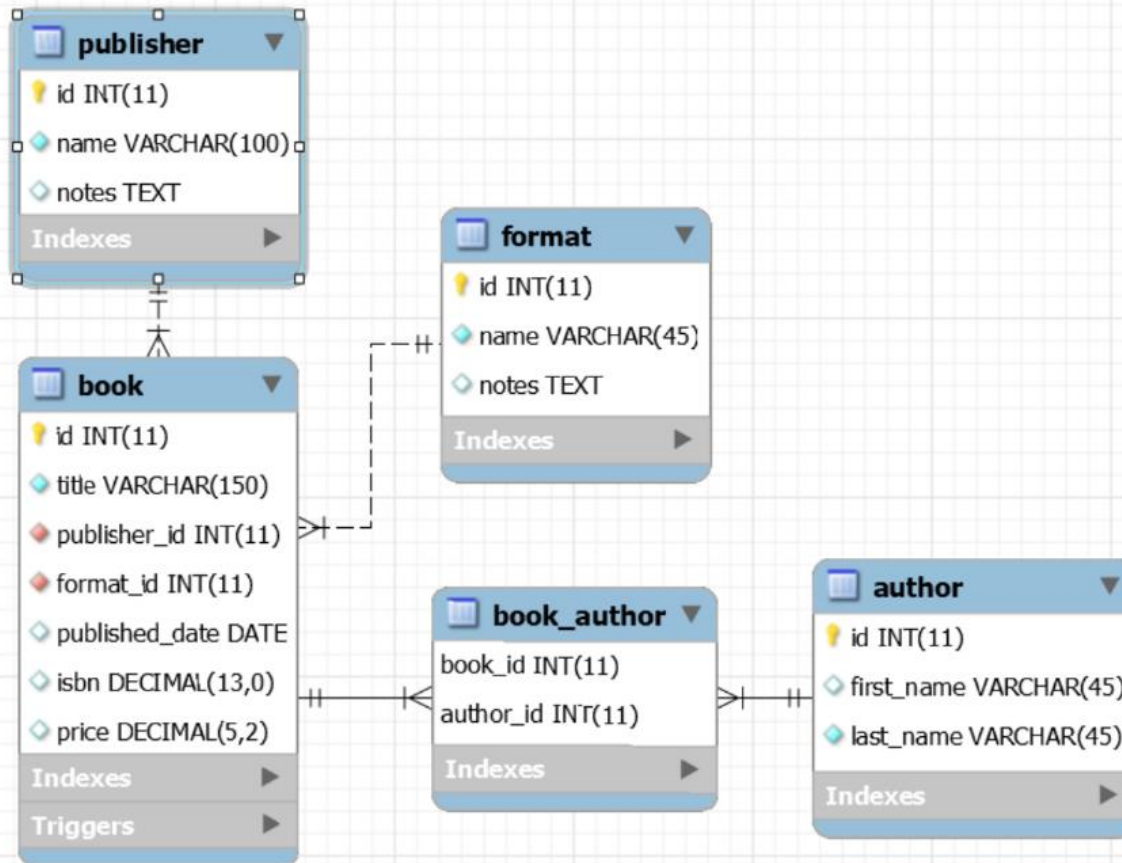
    @NotNull
    @Length(min=2, max=60)
    @Column(name = "first_name")
    private String firstName;

    @NotNull
    @Length(min=2, max=60)
    @Column(name = "last_name")
    private String lastName;

    @ManyToMany(mappedBy = "authors",
        fetch = FetchType.EAGER)
    List<Book> books = new ArrayList<>();
... }
```



JPA Entities: ER Diagram



Java Persistence Query Language

- ❖ Object-oriented database queries
- ❖ Navigation
- ❖ Abstract schema
- ❖ Path expression
- ❖ State field
- ❖ Relationship field

Java Persistence Query Language

❖ SELECT

❖ FROM

❖ WHERE

❖ GROUP BY

❖ HAVING

❖ ORDER BY

❖ UPDATE

❖ DELETE

❖ AS, IN

❖ LIKE

❖ EXISTS, ANY, ALL

❖ NEW

JPA Setup in Spring

```
<beans>
  <bean id="myEmf"
class="org.springframework.orm.jpa.LocalEntityManagerFactoryBean">
    <property name="persistenceUnitName" value="myPersistenceUnit"/>
  </bean>
</beans>
```

```
<beans>
  <jee:jndi-lookup id="myEmf" jndi-name="persistence/myPersistenceUnit"/>
</beans>
```

```
<beans>
  <bean id="myEmf"
class="org.springframework.orm.jpa.LocalContainerEntityManagerFactoryBean">
    <property name="dataSource" ref="someDataSource"/>
    <property name="loadTimeWeaver">
      <bean
class="org.springframework.instrument.classloading.InstrumentationLoadTimeWeaver"/>
    </property>
  </bean>
</beans>
```

JSR-303: Bean Validation (1)

- ❖ Bean Validation стартира през юли 2006 - JSR 303
- ❖ Финализирана е на 16 ноември 2009
- ❖ Валидацията е обща задача, която се осъществява през всички слоеве на приложението – от презентационния до персистирането на данните
- ❖ Често една и съща логика за валидация се реализира многократно във всеки слой, което води до чести грешки е несъответствия, както и до дублиране на усилия
- ❖ За да се справят с проблема, често разработчиците кодират валидационната логика директно в домейн модела, което води до смесване на бизнес логика и метаданни за валидиране на отделните свойства

JSR-303: Bean Validation (2)

- ❖ JSR 303: Bean Validation предлага набор от стандартни ограничения (constraints) относно данните, под формата на анотации, които обозначават полета, методи или класове на **JavaBean** компоненти, като например **JPA Entities** или **JSF Managed Beans**
- ❖ Има множество предварително дефинирани анотации, както и възможност за създаване на собствени такива и свързването им с клас, който да реализира валидационната логика
- ❖ Вградените анотации са дефинирани в пакет **javax.validation.constraints**

Bean Validation Annotations (1):

- ❖ **@AssertFalse** – елемент от булев тип трябва да е лъжа
- ❖ **@AssertTrue** – елемент от булев тип трябва да е истина
- ❖ **@Min, @DecimalMin** – минимална стойност на елемент от ЧИСЛОВ ТИП
- ❖ **@Max, @DecimalMax** – максимална стойност на елемент от ЧИСЛОВ ТИП
- ❖ **@Digits** – атрибути fraction и integer за дробната и цялата част на елемент от числов тип
- ❖ **@Future** – валидиране на бъдеща дата (Date и Calendar)
- ❖ **@Past** – валидиране на минала дата (Date и Calendar)
- ❖ **@Size** – min и max размер на String, Collection, Map или Array

Bean Validation Annotations (2):

- ❖ **@NotNull** – елементът трябва да е различен от null
- ❖ **@Null** – елементът трябва е null
- ❖ **@Pattern** – елементът трябва да съответствува на посочения в атрибута regex регулярен израз
- ❖ **@Valid** – анотация в пакета javax.validation, която указва, че трябва да се извърши рекурсивна валидация на всички обекти свързани с посочения обект
- ❖ Възможно е създаване на нови собствени анотации и композитни анотации с използване на **@Constraint**, **@GroupSequence**, **@ReportAsSingleViolation**, **@OverridesAttribute**

Bean Validation Examples:

```
public class Email {  
    @NotEmpty @Pattern(".*+@.*+\\.[a-z]+")  
    private String from;  
    @NotEmpty @Pattern(".*+@.*+\\.[a-z]+")  
    private String to;  
    @NotEmpty  
    private String subject;  
    @Min(1) @Max(10)  
    private Integer priority;  
    @NotEmpty  
    private String body;  
    ...  
}
```

Bean Validation – Custom Annotation:

@Size(min=4, max=4)

@ConstraintValidator(validatedBy = **PostCodeValidator.class)**

@Documented

@Target({ANNOTATION_TYPE, METHOD, FIELD})

@Retention(RUNTIME)

```
public @interface PostCode {  
    public abstract String message() default  
        "{package.name.PostCode.message}";  
    public abstract Class<?>[] groups() default {};  
    public abstract Class<? extends ConstraintPayload>[]  
        payload() default {};  
}
```

Bean Validation – Class PostCodeValidator

```
public class PostCodeValidator implements
    ConstraintValidator<PostCode, String> {
    private final static Pattern POSTCODE_PATTERN =
        Pattern.compile("\\d{4}");
    public void initialize(PostCode constraintAnnotation) { }
    public boolean isValid(String value,
        ConstraintValidatorContext context) {
        return POSTCODE_PATTERN.matcher(value).matches();
    }
}
```

Bean Validation – композитна анотация:

```
@ConstraintValidator(validatedBy = {}) @Documented
@Target({ANNOTATION_TYPE, METHOD, FIELD})
@Retention(RUNTIME)
@Pattern(regexp = "\\d{4}")
@ReportAsSingleViolation
public @interface PostCode {
    public abstract String message() default
        "{package.name.PostCode.message}";
    public abstract Class<?>[] groups() default {};
    public abstract Class<? extends ConstraintPayload>[]
        payload() default {};
```

Additional Examples

Learning Spring 5 book examples are available @
GitHub:<https://github.com/PacktPublishing/Learning-Spring-5.0>

Spring 5 Core Reference Documentation:
<https://docs.spring.io/spring/docs/current/spring-framework-reference/data-access.html>

JPA in Java EE 6 Tutorial –
<https://docs.oracle.com/javaee/6/tutorial/doc/bnbpy.html>

Thank's for Your Attention!



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